

Implementing Autonomous and Connected Vehicle Technologies in the Park Setting

Project Background

The National Park Service (NPS) is interested in understanding the potential opportunities and challenges of autonomous and connected vehicle (AV/CV) technologies on its lands. With a unique mission to protect America's natural and cultural resources for the public to enjoy, NPS's transportation system is challenged with providing visitor access and mobility while avoiding or mitigating impacts to the environment. Fast-progressing AV/CV technology presents an opportunity to assist NPS in meeting these goals as well as assisting in addressing current challenges of increasing visitation creating vehicular congestion and AV vendors approaching parks for future partnerships.

The project was guided by the following researchable questions:

1. Will AV/CVs add value to parks?
2. What does the NPS need to do to accommodate AV/CVs?
3. How would different park types integrate AV/CVs?

Problem Statement

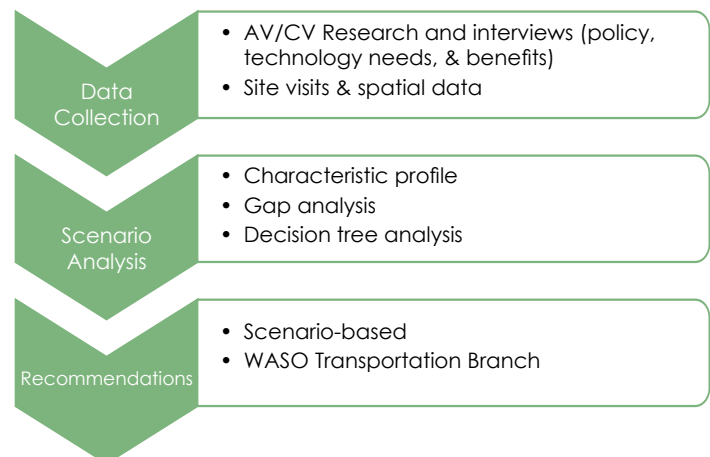
With emerging AV and CV technology and policy, the NPS will evaluate how to best prepare its unique transportation system and services to take advantage of AV and CV opportunities, while mitigating potential challenges.

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Methodology

To answer the researchable questions and address the problem statement, we first collected data on AV/CV policy, technology and needs as well as conducted four site visits and one virtual site visit of case study parks. We then used that information to develop a Scenario Analysis that assessed our case study park's suitability and compatibility for AV/CV technology. The findings resulted in a set of recommendations for each scenario and more general recommendations for the NPS Washington Support Office (WASO) Transportation Branch.



Data Collection

AV and CV Legislation

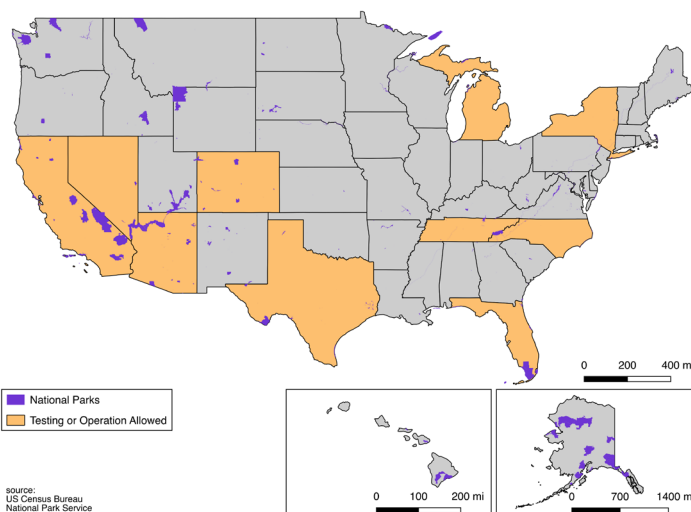
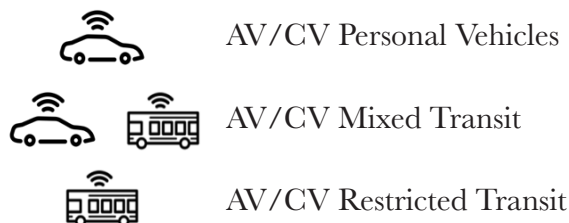
The NPS units are required to adhere to federal, state, and local regulation regarding autonomous vehicles and connected vehicles. Different state and local policy will impact how and when AVs and CVs are implemented on the NPS park units, demanding legislation tracking for phasing of AV/CV implementation. The SELF DRIVE Act and AV START Act are undergoing review at the federal level to reveal the federal stance on autonomous vehicles. Currently, a total of fifty-two bills and eleven Executive Orders have been passed across thirty-three states, with only ten states allowing the testing and operation of autonomous vehicles on public streets as of April 2018.

AV/CV Benefits

Potential Benefit	AV	CV
Safety	+	+
Operational Savings	±	-
Environmental	+	+
Visitor Experience	+	+
Data & Reporting	○	+
Legend: + positive - negative ± unclear ○ no benefits		

AV/CV End-State Scenarios

The project team envisions three end-state scenarios, which are used to analyze the potential impacts of AVs on travel to and within National Park units.



State of AV/CV Technology

The team sought to understand the technological requirements and capabilities of AVs and CVs separately by conducting literature review and expert interview (see Appendix C for list of interviewees). We explored AVs and CVs separately for two reasons: 1) the technologies are currently being developed separately, and 2) the benefits and requirements are different

AV Needs

- High definition roadway map data
- Amenable weather conditions (subject to change as technology progresses)
- State policy allowing autonomous testing and operations
- Transit-only staffing needs (depending on purchasing agreement)
- Optional infrastructure needs
 - Data management and storage
 - Data sharing requirements with OEM

CV Needs

- Roadside equipment (RSE)
- Data management, storage, and cybersecurity infrastructure
- Expanded cellular service (5G)

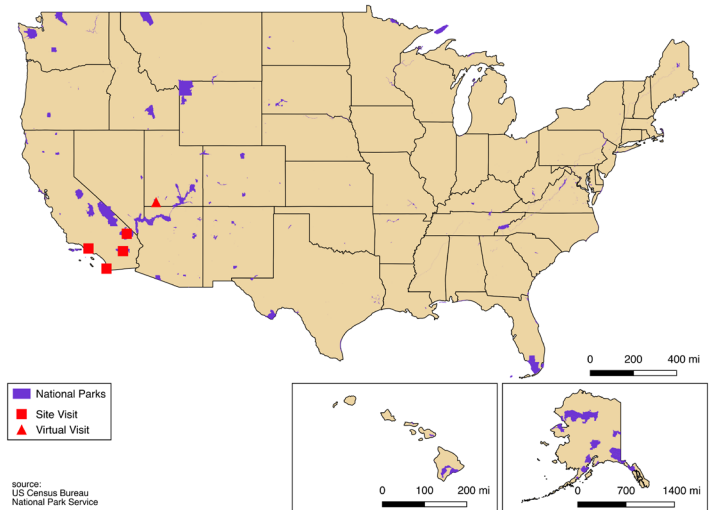


Case Study Park Selection

Due to time and resource constraints, we were limited to assessing the characteristics of only four site visit parks and one virtual park visit:

- Cabrillo National Monument
- Joshua Tree National Park
- Mojave National Preserve
- Santa Monica National Recreation Area
- Zion National Park (virtual)

We believe the case study parks are representative of many of the different park types found across the country. Our primary considerations were whether the parks were urban or rural, and high/low visitation.



Findings by Case Study Park

The three steps of the Scenario Analysis which assessed future park unit suitability and compatibility for AV/CV technology are listed below and were applied to each case study park:

- Characteristic Profile - Determine current infrastructure and policy conditions, along with park-specific considerations.
- Gap Analysis - Evaluate gaps between AV/CV requirements and current conditions.
- Decision Tree - Create a decision tree for future AV/CV end-state scenario at National Parks.

Characteristic Profile

Characteristics	Cabrillo National Monument	Joshua Tree National Park	Mojave National Preserve	Santa Monica Mountains National Recreation Area	Zion National Park
Dynamic Characteristics					
Road Condition	●	●	○	⊗	●
Congestion	●	●	○	●	●
Cellular Service	●	○	○	●	●
Data Management	○	○	○	○	○
Static Characteristics					
Visitor Use	day-use	day-use; camping	day-use; camping; off-roading	day-use	day-use; camping
Roadway Pattern	linear	linear	dispersed	dispersed	linear
Weather	frequent fog	favorable	occasional monsoon	favorable	favorable
Gateway City Amenities	●	●	●	●	●
Parking Near Entrance	●	●	○	○	●
Controlled Access	●	●	○	○	●
Through-Traffic	○	○	●	●	○
Key	● Met ● Partially Met ○ Not Met ⊗ Unknown				

Gap Analysis

Gaps / Case Parks	Cabrillo National Monument	Joshua Tree National Park	Mojave National Preserve	Santa Monica Mountains National Recreation Area	Zion National Park
AV	●	●	●	●	●
CV Add-On	●	●	○	●	●
Transit	●	●	○	●	●
Restriction	●	●	○	●	●
Key	● No Gap ● Partial Gap ○ Gap				

Decision Tree End-State

Cabrillo National Monument

AV Restricted Transit with CV Add On

Joshua Tree National Park

AV Mixed Transit with CV Add On

Mojave National Preserve

AV Personal

Santa Monica National Recreation Area

AV Personal

Zion National Park

AV Restricted Transit with CV Add On

Future End State Specific Scenario Recommendations

AV/CV Preparation Needs	AV Personal Vehicles	AV Mixed Transit	AV Restricted Transit	If Pursuing CV Add-On
HD Roadway Map	X	X	X	<ul style="list-style-type: none"> • Installation of RSE • Consider data management, storage, and cybersecurity infrastructure • Expanded cellular service
Monitor Congestion	X	X		
Staff for Operation and Maintenance of Vehicles		X	X	
Electrical Charging Infrastructure		X	X	
Vehicle Staging Areas			X	
Coordination with Gateway City			X	
Secure Entrances/Exits and Enforce Restriction			X	

WASO Recommendations

The following recommendations are to assist the agency's Washington Support Office (WASO) Transportation Branch leadership in mitigating the challenges and realizing the benefits associated with AV/CV implementation.

AV/CV Preparation Recommendation

These recommendations address the ways in which the WASO Transportation Branch can begin to prepare for the introduction of AV/CVs into the NPS's transportation system. These recommendations address themes from our research that ensure AV/CVs are implemented on Park Service land in a way the NPS can control.

- Think about big data
- Track State Policies
- Examine NPS Policies and Update as Necessary for AV/CVs

AV/CV Implementation Recommendation

The below recommendations present opportunities in which the NPS can implement AV/CV technology in an informed and intentional way.

- Replicate the Scenario Analysis with Park Units
- Implement a Pilot based on Scenario Analysis Findings
- Consider working with a provider in which partner covers costs, agrees to share data, and recognizes risk sharing

Acknowledgements

Photo 1: Joshua Tree National Park, Gabrielle Tilley Photography

Photo 2: Joshua Tree National Park, Nicole Enciso

Vehicle Icons: The Noun Project

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